Echo Lake Water Quality

A Report on Water Quality Monitoring Results
for Water Year 2011 at Echo Lake

King County Lake Stewardship Program

Prepared for the City of Shoreline
by the King County Lake Stewardship Program

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King County

Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Echo Lake in 2001. The lake was not monitored in 2002, but work resumed in 2003 and has continued to the present. In 2005, City of Shoreline staff members began sampling the lake according to the protocols and schedule of the volunteer monitoring program run through the KCLSP. The water quality data indicate that currently the lake is moderately high in primary productivity with fair water quality.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae that could be produced in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict what groups of algae may become dominant in the lake during certain periods. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2011 water year. Specific data used to generate the charts in this report can be downloaded from the King County Lake Stewardship data website at:

http://www.metrokc.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx.

Or can be provided in the form of excel files upon request.

Physical Parameters

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

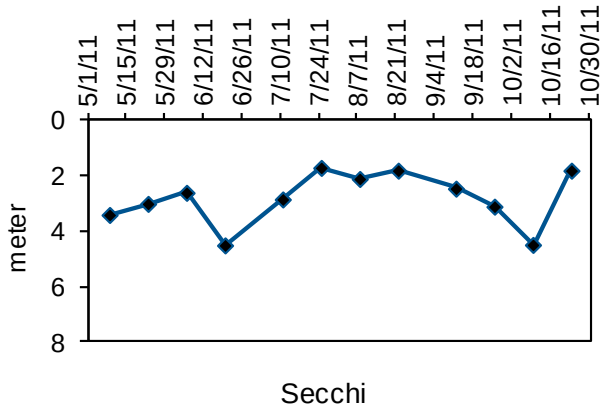

Figure 1. Echo Lake Secchi Transparency

For Echo Lake, Secchi transparency values collected from May through October ranged from 1.7 m to 4.5 m, averaging 2.8 m (Figure 1). Note that the Y-axis is traditionally reversed on Secchi charts from the usual direction of increase to mimic looking into the water. Compared to data collected in previous years, the Secchi transparency values

exhibited similar variability through the season. The high value in mid-June coincides with the decline of chlorophyll values (see later in this report), indicating that increased transparency was due to the crash of an algae bloom. This may also be true of the August values, although the chlorophyll values were lower at that time than in mid-June.

Water temperatures during the May-October sampling period generally followed a pattern similar to other lakes in the region, with cool temperatures in the spring, followed by summer maximum temperatures occurring between mid-July and mid-August, and then temperatures cooling slowly in the fall (Figure 2). Echo Lake water temperature at 1 m depth ranged from 12.9 degrees Celsius to 21.9 degrees Celsius with an average of 17.9. Compared to other lakes monitored through the KCLSP in 2011, Echo Lake is in the lower third in terms of summer temperature maxima. The peak temperature occurred in mid to late August.

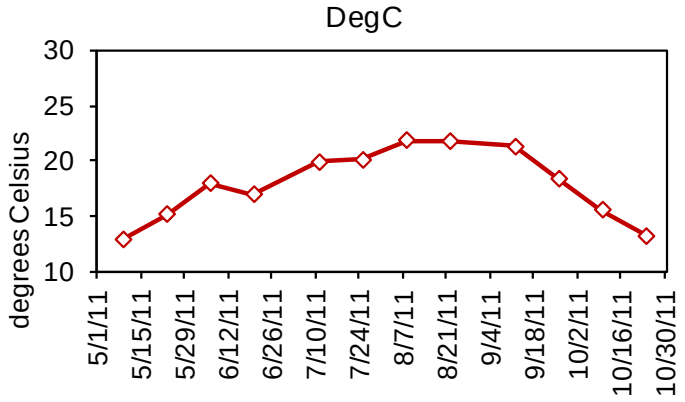

Figure 2. Echo Lake Water Temperatures

Nutrient and Chlorophyll Analysis

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms, making a nuisance to residents and lake users and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

Total phosphorus (TP) and total nitrogen (TN) increased from May sample dates to a large peak in June, followed by a similar sized decrease in late June, a small peak in nitrogen only in August, and then phosphorus rose on the last sample date (Figure 3). The large increase for both TN and TP in June can be attributed to an algae bloom.

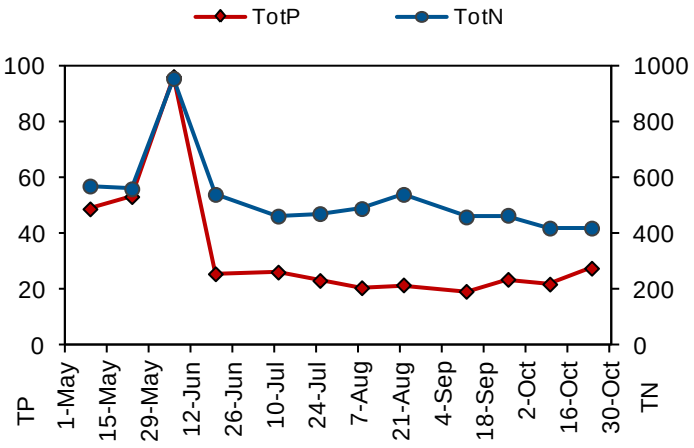

Figure 3. Echo Lake Nutrients

The ratio of nitrogen (N) to phosphorus (P) can be calculated to determine if conditions were favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. When N:P ratios are near or below 20, cyanobacteria often dominate the algal community due to their ability to take nitrogen from the air. In 2011, the N:P ratio at Echo Lake ranged from 9.9 to 25.1 with an average of 18.2, which indicated that the conditions in the lake were favorable for bluegreen algae blooms for much of the sample period. In particular, the spring and fall had optimal nutrient conditions for bluegreen blooms.

Chlorophyll *a* values in 2011 had a moderate peak in late May and early June, coincident with the nutrient peaks although not as pronounced, with a minor peak in early August and a large increase through October (Figure 4). These peaks likely indicate algae blooms occurring at the lake.

Pheophytin, a decomposition produce of chlorophyll, remained at low levels most of the season except for a slight increase during early August.

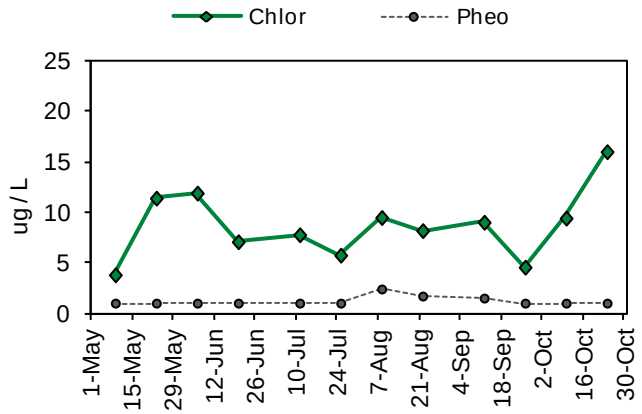

Figure 4. Echo Lake Chlorophyll *a* and Pheophytin Concentrations

Profile data indicate that thermal stratification was present early in the season and persisted through the summer (Table 1). For the events sampled in both May and August, the deep (7 m) meter samples had elevated concentrations of phosphorus and orthophosphate, although the August measurement in the deep water was 6 times higher than that in late May. Ammonia (NH3) concentrations were also high, suggesting that anoxic conditions contributed to the elevated nutrient levels in the deep water via sediment release.

Chlorophyll data suggest that in the early part of the sampling season most algae were in the upper portion of the water column, but in late summer more were to be found in the deeper portion of the water column, possibly taking up phosphorus released from the sediments.

Table 1: Echo Lake Profile Sample Analysis Results. Sample values below minimum detection level are marked <MDL.

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Echo-Shore	5/23/11	3.0	1	15.2	11.4	<MDL	0.560	0.006	0.0532	0.0105	0.100	19.5
Echo-Shore	5/23/11		3	15.0	3.9	<MDL	0.503		0.0503			
Echo-Shore	5/23/11		7	9.0	2.2	1.6	0.718	0.173	0.0755	0.0601		
Echo-Shore	8/22/11	1.8	1	21.8	8.2	1.7	0.540	<MDL	0.0215	<MDL	0.092	17.9
Echo-Shore	8/22/11		3	21.8	6.4	2.2	0.688		0.0598			
Echo-Shore	8/22/11		7	9.6	32.8		1.060	0.608	0.4370	0.0819		

NOTE: In Table 1, <MDL stands for "below minimum detection level" of the analytical method.

The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances, while the total alkalinity values show that the water in the lake is soft, with little buffer capacity against pH change.

TSI Ratings

A common method of tracking water quality trends in lakes is by calculating values for the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of a lake based on water clarity (Secchi transparency), as well as concentrations of total phosphorus and chlorophyll *a*.

For Echo Lake, the annual average of the 3 indicators from 2001 through 2010 does not show a solid trend towards change over time, although there appears to be a period of increase recently between 2008 – 2010 (Figure 5). However, in 2011 the TSI values dropped back to 2007 levels, and it will be interesting to see if this is sustained in 2012 or will prove to be a short-lived decrease. The Secchi measurement generally predicted lower algal biovolumes than the other two parameters, which may be due to the clumping or particulate nature of the cyanobacterial species that dominated the phytoplankton. Algae making relatively larger particles do not impact water clarity as much as small algae that produce cloudiness when abundant.

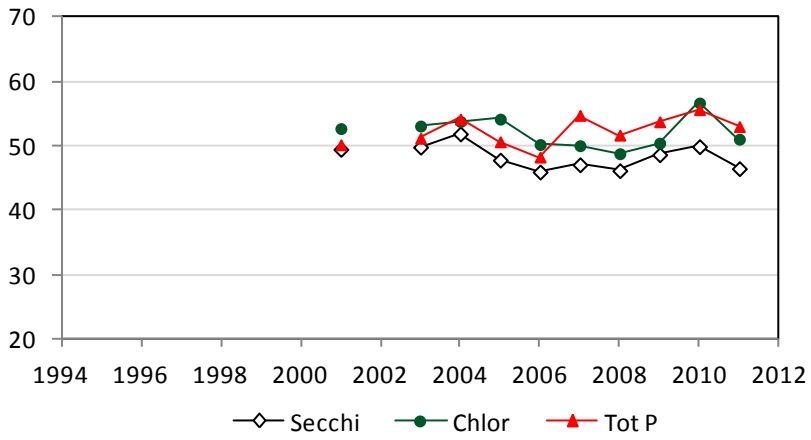

Figure 5. TSI Values at Echo Lake

Cyanobacteria toxins

Because of its history of occasionally producing bluegreen (cyanobacteria) blooms, Echo Lake was chosen as one of 30 Puget lowland lakes to be studied as part of work funded by a grant from the Federal Center for Disease Control (CDC) to the Washington Department of Health, working in collaboration with King, Snohomish, and Pierce Counties. The study involves regular biweekly sampling at a selected site for bluegreen species abundance and toxicity between June and October for three consecutive years between 2009 and 2011. Four algal toxins were measured in 2011: microcystin, anatoxin-a, saxitoxin and cylindrospermopsin.

In Echo Lake, the routine site chosen for monitoring was at the public park because that is the point at which the most people and pets come in contact with the water. All toxins were below detectable levels on first three sample dates in the 2011 season. However, microcystin was present at low levels below 1 ug/L for the remaining 7 sampling events. No detectable amounts of the other 3 toxins were found. Aside from the routine samples, no bloom samples were submitted under the Washington Department of Ecology algae program. Compared to 2009, 2011 was a very quiet year for cyanobacteria toxicity in Echo Lake (Table 2).

Table 2: REHAB routine monitoring results for cyanobacteria toxins

ROUTINE										
Sample ID	Collect Date	Client Locator	Anatoxin-a VALUE (ug/L)	Anatoxin-a MDL (ug/L)	Cylindrospermopsin VALuE (ug/L)	Cylindrospermopsin MDL (ug/L)	Microcystin VALUE (ug/L)	Microcystin MDL (ug/L)	Saxitoxin VALUE (ug/L)	Saxitoxin MDL (ug/L)
L53006-9	6-Jun-11	ECHO	0.05	0.05	0.1	0.1	0.05	0.05	0.02	0.02
L53009-9	20-Jun-11	ECHO	0.05	0.05	0.1	0.1	0.05	0.05	0.02	0.02
L53010-9	11-Jul-11	ECHO	0.05	0.05	0.1	0.1	0.05	0.05	0.02	0.02
L53011-9	25-Jul-11	ECHO	0.05	0.05	0.1	0.1	0.0745	0.05	0.02	0.02
L53528-9	8-Aug-11	ECHO	0.05	0.05	0.1	0.1	0.114	0.05	0.02	0.02
L53529-9	22-Aug-11	ECHO	0.05	0.05	0.1	0.1	0.201	0.05	0.02	0.02
L53530-9	12-Sep-11	ECHO	0.05	0.05	0.1	0.1	0.086	0.05	0.02	0.02
L53531-9	26-Sep-11	ECHO	0.05	0.05	0.1	0.1	0.168	0.05	0.02	0.02
L53532-9	10-Oct-11	ECHO	0.05	0.05	0.1	0.1	0.0835	0.05	0.02	0.02
L53533-9	24-Oct-11	ECHO	0.05	0.05	0.1	0.1	0.0575	0.05	0.02	0.02
BLOOMS										
No bloom samples taken										

Conclusions and Recommendations

Based on the monitoring data, water quality in Echo Lake appears to have been relatively stable over the period measured, although there was a short-lived series of increases in 2008 – 2010. In 2011 the trophic state indicators declined to more typical values for the lake. However, the relatively few years of monitoring do not as yet produce a reliable estimation of trends.

Low N:P ratios throughout most of the monitoring period in 2011 indicated conditions favorable for nuisance bluegreen algae blooms. However, routine toxicity testing through the Regional Examination of Harmful Algal Blooms project turned up only very low levels of toxicity in the 2011 season. Close monitoring of algae blooms at the lake in the spring and fall should continue, including continued participation in the CDC grant project and the Washington State Department of Ecology's Toxic Algae Monitoring program to determine whether or not blooms at the lake produce toxins above the recommended recreational threshold on a regular basis.